Unfinished structural change and sectoral heterogeneity: the case of Mexico

Ramón Padilla-Pérez and Francisco G. Villarreal

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Ramón Padilla-Pérez [a] and Francisco G. Villarreal [b]
Economic Commission for Latin America and the Caribbean (ECLAC)
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Abstract

Mexico, as other Latin American countries, undertook far-reaching economic reforms in the 1980s and 1990s in a wide array of areas. As a result, the Mexican economy experienced outstanding export growth, successful insertion into global markets and a shift towards medium and high-technology industries. Yet productivity growth was insufficient, leading to low and volatile economic growth. This paper examines the dynamics of productivity growth and in particular inter- and intra-industry dynamics, making use of a shift-share analysis and the rich detail available in a novel industry data set. The paper shows that Mexico has experienced an unfinished structural change, in which spells of intra sectoral productivity expansion have been hampered by severe losses during crises, resulting in insufficient productivity growth over the period 1990-2012 to close the gap with its main trading partner, the United States. Moreover, despite a significant reallocation of hours worked across industries, its aggregate impact has been hindered by the prevalence of flows from industrial sectors with high labor productivity growth towards those with lower or contracting productivity growth.

Keywords: Structural change; productivity growth; aggregate productivity; Mexico
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The views expressed in this document, are those of the authors and do not necessarily reflect those of the Organization.

[a] Corresponding author: Economic Affairs Officer, International Trade and Industry Unit (ramon.padilla@cepal.org). Postal address: Miguel de Cervantes Saavedra 193, 12th Floor, Colonia Granada, 11510, Mexico City, Mexico. Phone number: +52 5541705600.
[b] Economic Affairs Officer, Economic Development Unit (francisco.villarreal@cepal.org). Postal address: Miguel de Cervantes Saavedra 193, 12th Floor, Colonia Granada, 11510, Mexico City, Mexico. Phone number: +52 5541705600.

Introduction

There is a wide acknowledgement that structural change is needed for long-term economic development (ECLAC, 2012; Lin, 2012; McMillan and Rodrik, 2011; UNIDO, 2009; Haussman and Rodrik, 2003). Since the industrial revolution, the rise of new economic powers has generally been driven by the structural transformation of their economies, characterized by the shift from primary production to manufacturing, or from manufacturing to services, and within manufacturing from natural-resource-based goods to medium and high-technology products (Lin, 2012; Memedovic and Iapadre, 2009).

Structural change involves transforming the composition of output, international trade and employment (ECLAC, 2012). Through increasing productivity in existing activities, and moving towards more complex and technology-intensive sectors and processes, structural change is expected to lead to higher long-term economic growth, increased export competitiveness and better-paid jobs.

Mexico is an interesting case among emerging economies to study structural change over the last three decades. Since the mid-1980s, Mexico's economic policies and overall development orientation underwent extensive changes. The underlying premise was to use exports, instead of the domestic market, as the engine of growth and the private sector, instead of the State, as the driver of the new machine (Cordero et al., 2009).

As a result, the export and production structure were transformed significantly: in 1986, exports of primary goods represented 45.6% of total exports, and by 2012 they had decreased to 17.4%. In contrast, exports of medium and high-technology products increased from 33.0% to 61.8% of total exports in the same period (ECLAC, 2014a). This concentration on medium and high-technology products is higher than in any of the so-called BRICS countries[1]; in China those products accounted for 56.9% of total exports in 2012 (ECLAC, 2014a). Mexico has also gone through a successful insertion into high-growth global markets and has shown remarkable export competitiveness. Its market share in total United States' imports, which is the largest import market in the world, rose from 6.1% in 1990 to 12.2% in 2012, in spite of increasing Asian competition (ECLAC, 2014b).

Yet Mexico has experienced low and volatile economic growth (between 1990 and 2012, Mexico's economy grew only at 2.2% annually on average), which has been closely associated with slow productivity growth (McKinsey Global Institute, 2014; OECD, 2013; Kehoe and Ruhl, 2010; López-Córdova, 2003).

This paper examines the dynamics of productivity by sector and assesses whether inter and intra-industry dynamics can account for sluggish aggregate productivity growth. The analysis decomposes labor productivity growth through the use of a shift-share analysis, taking advantage of a recently published industry-level database developed by the Mexican

[1] Brazil, the Russian Federation, India, China and South Africa.

National Statistics Office (INEGI) as part of the LA-KLEMS project[2] (INEGI, 2014; Aravena and Hofman 2014). The database consists of annual industry-level time-series of output, as well as labor, capital and intermediate inputs over the period 1990-2012. The level of disaggregation available in the database allows a detailed analysis of the dynamics of resource allocation across industries. To the best of our knowledge this study is the first to apply this methodology to analyze the Mexican case.

The main contribution of this paper is to show that Mexico has experienced an incomplete or unfinished structural change over the last three decades. Although it has succeeded in diversifying its production matrix and shifted towards more technologically complex industries, productivity growth has been unsatisfactory and quite below that of its main trading partner, the United States. On the one hand, productivity growth within sectors has been sluggish in general; on the other sectoral shifts have been characterized by the relocation from industries with high productivity expansion to those with low or negative rates of growth. The findings of this paper are relevant to other developing economies which have followed a similar economic development model, such as those of Central America.

The paper is divided into four further sections. The first section presents the main concepts used in this paper, in particular a detailed definition of structural change. It also provides details about the database used to estimate productivity. The second section describes the main features of the Mexican economy under the economic model implemented in the previous three decades. The third section offers an in-depth analysis of productivity growth by sector in Mexico and its comparison with United States performance. The fourth section concludes.

1. Conceptual framework and methodology

Economic theory, since its origin, has given significant attention to structural change. For Adam Smith (1776) and David Ricardo (1817) the structural composition of the economy was strongly related to economic development and growth. By the same token, for economic development theory pioneers -such as Allan Fisher (1939), Hollis Chenery (1960), Arthur Lewis (1954), Luigi Pasinetti (1981) and Nicholas Kaldor (1957)- structural change is a key element for robust and sustainable growth. More recently, after the international 2008-2009 crisis, there has been a renewed interest in the quest for long-term economic growth and structural change has been brought to the fore again (e.g. ECLAC, 2012; Lin, 2012; McMillan and Rodrik, 2011).

Structural change has been understood in many different ways. Three main complementary definitions are here adopted. First, structural change results from innovations and increasing productivity in existing sectors, which may come from product, process and

[2] The LA-KLEMS Project is based on the EU-KLEMS Project developed by the Groningen Growth and Development Centre for the European Union (Ref needed). The KLEMS growth and productivity accounts include measures of output growth, productivity, employment and skill creation, capital formation and technological change at the industry level. The input measures include various categories of capital (K), labour (L), energy (E), materials (M) and services (S).

functional upgrading (ECLAC, 2012). Product upgrading is the development and commercialization of new or improved products with enhanced performance characteristics. Process upgrading involves the development and implementation of new or significantly improved production or delivery methods (OECD, 2005). Functional upgrading, in turn, means engaging in new and superior activities in the value chain, for instance, when a firm moves from components manufacturing to product design (Humphrey and Schmitz, 2002).

Second, structural change has been commonly associated with long-term and persistent shifts in sectoral composition of economic systems. It entails modifications in the relative importance of different sectors over time, measured by their share in employment, output and trade (Memedovic and Iapadre, 2009; Hausmann and Rodrik, 2003). But more important for long-term economic growth, it is characterized by an increase in the contribution of knowledge-intensive sectors or activities to output and trade and a denser and more diversified production matrix (ECLAC, 2012).

Third, structural change is also associated to insertion into high-growth global markets, leading to growing aggregate demand, production and job creation (ECLAC, 2012). Therefore, it entails a transformation towards sectors and activities that are increasingly demanded in global markets. Growing market share of international markets is a result of this transformation.

Economic catching-up theories assert that to open an economy to international trade creates the conditions to develop local technological capabilities and increase productivity, therefore engaging in a structural change process. This is based on the expected positive effects that opening up to international trade has on technological capabilities through exports of goods, imports of intermediate and capital goods and foreign direct investment (FDI).

The catching-up theory in its simple form asserts that being backward in productivity level carries a potential for rapid advance. The catching-up theory can be traced back to Veblen's (1915) and Gerschenkron's (1962) analyses of the process by which England was overtaken by other countries such as Germany and Russia in the nineteenth and early twentieth centuries. In comparisons across countries, growth rates of productivity over long periods tend to be inversely related to the initial level of productivity. The central idea has to do with the level of technology embodied in a country's capital stock. The larger the technological gap, and therefore the productivity gap between leader and follower, the stronger the follower's potential for growth in productivity.

However, according to Abramovitz (1986), "a country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced" (p. 388). Thus the catching up process is conditioned on what Abramovitz called "social capabilities", which are related to education, institutions, and policies. Based partly on the results of Easterly and Levine (2001), which highlight the importance of differences in productivity in explaining cross-country income heterogeneity, endogenous growth theory has further elaborated on the role of international trade and integration in the diffusion and absorption of technology (Keller, 2004).

At its most abstract level, productivity refers to the volume of outputs that can be produced from a given bundle of inputs. Its relevance stems from the fact that sustained differences in the rate of growth of productivity explain a substantial portion of the heterogeneity observed in income levels across countries (IADB, 2010; Crespi, 2010; Easterly and Levine, 2001). Thus, the analysis of its dynamics and its determinants is of the utmost importance from the perspective of development.

The particular definition of productivity depends on the objective of measurement, as well as to the availability of data. Considering the close association between labor productivity and income per capita, this paper focuses on this measure which is defined as the quotient between value-added, expressed in constant terms, and the number of hours worked.

The methodology used is a shift-share analysis of labor productivity (Fabricant, 1942). It allows the decomposition of changes in labor productivity into two components: pure-productivity gains within industries (intra-sectoral or within change), and the effect due to the reallocation of resources across industries (inter-sectoral or between change). Following the work of Maudos et al. (2008), inter-sectoral changes in productivity are further decomposed into those which are due to the reallocation of resources to industries with higher productivity levels (static sectoral effect), and those due to the reallocation towards industries with higher rates of productivity growth (dynamic sectoral effect):

$$\frac{Y_T}{H_T} - \frac{Y_0}{H_0} = \underbrace{\sum_{i=1}^{n} \theta_{i,0} \left(\frac{Y_{i,T}}{H_{i,T}} - \frac{Y_{i,0}}{H_{i,0}} \right)}_{Intrasectoral\ change} + \underbrace{\underbrace{\sum_{i=1}^{n} \frac{Y_{i,0}}{H_{i,0}} (\theta_{i,T} - \theta_{i,0})}_{Static\ effect} + \underbrace{\sum_{i=1}^{n} (\theta_{i,T} - \theta_{i,0}) \left(\frac{Y_{i,T}}{H_{i,T}} - \frac{Y_{i,0}}{H_{i,0}} \right)}_{Dynamic\ effect}}_{Intersectoral\ change}$$

where $Y_T/H_T - Y_0/H_0$ denotes aggregate labour productivity growth between periods T and 0, and $\theta_{i,T}$ represent the share of hours worked in industry i as a proportion of total hours worked during period T: $\theta_{i,T} \equiv H_{i,T}/\sum_i H_{i,T} = H_{i,T}/H_T$.

The decomposition afforded by the shift-share analysis isolates the different sources of productivity growth. The first term on the right hand side measures the change in productivity that would have occurred solely due to improvements in efficiency within industries. Thus, it reflects changes in productivity that result from supply-side driven innovations within industries (Schumpeter, 1939), along the lines of the first notion of structural change presented above. The second term measures productivity changes that would have occurred only due to the flow of labor across industries. That is, it measures the demand-side induced reallocation of resources between sectors (Pasinetti, 1981). This second term correspond to both the second and the third definitions of structural change. Finally the third term measures the interaction between labor flows across industries, and the productivity gains within industries, in line with the first and second concepts of structural change. Positive values of this term reflect what Baumol (1967) called the structural bonus that results from labor shifts from industries where productivity growth is low or contracting, towards industries where productivity is growing at a faster rate.

2. Export competitiveness and industrial recomposition in Mexico over the last three decades

In the 1980s and 1990s, Mexico, as other Latin American countries, undertook a far reaching program of economic reforms in different areas: trade and industrial policy, foreign investment and capital account liberalization, privatization of public enterprises, and deregulation of domestic economic activities.

Trade policy reform began with unilateral liberalization of international commerce in 1984. In 1986, Mexico joined the General Agreement on Tariffs and Trade (GATT) and the government committed itself to maximum tariff rates and pledged to continue the replacement of import controls by tariffs. In the 1980s, 1990s and the first decade of the 2000, Mexico was very active in negotiating and signing free trade agreements (FTAs) with various countries and regions. The North American Free Trade Agreement (NAFTA), with the United States and Canada, went into effect in January 1994. By 2013, FTAs had been signed with more than 40 countries, including the European Union, the European Free Trade Association, the five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua), Chile, Bolivia, Uruguay, Venezuela, Colombia and Israel, locking up trade openness and securing significant tariff reductions for most of its tradable goods.

As a result of this new economic model, Mexico's exports have experienced an outstanding expansion over the last two decades: between 1993 and 2013, they grew at an annual average rate of 10.5% (in current dollars). Mexico is by far the largest exporter in Latin America, contributing with one-third of total regional exports. In 2013, its exports amounted to US$ 380.2 billion, well above Brazil's US $242.2 billion.

Export competitiveness, understood as an increasing market share, has been also noteworthy. In 2012, Mexico possessed 12.2% of total United States' imports market, in comparison with 6.9% in 1993, in spite of increasing Asian competition. Mexico is the third largest exporter to the United States, just behind China and Canada.

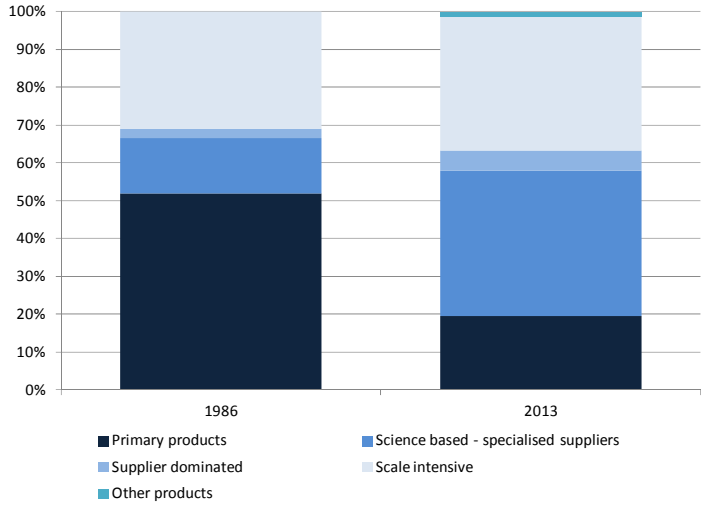
Moreover the composition of exports has undergone a significant transformation. A taxonomy proposed by Castaldi (2009), which combines the taxonomies of Pavitt (1984) and of Miozzo and Soete (2001), is here used. The central idea behind the taxonomy is to classify industries according to both the sources and dynamics of innovation within industries. Manufacturing industries are classified into three categories: i) Scale intensive industries, whose efficiencies are to be found in the scale of their operations and whose innovations stem mostly in process improvement[3]; ii) Supplier dominated industries, which are characterized by the fact that they derive the majority of their innovations from improvements embodied in the capital and intermediate goods provided by specialized suppliers[4]; and finally iii) Science-based and specialized suppliers which rely mainly on

[3] Of particular interest for the case of Mexico, this category includes the manufacture of transport equipment, chemical products, and food products and beverages.
[4] This category includes textiles, apparel and paper products.

formal research activities to produce their own innovations.[5] An additional category of producers of primary products is included, to take into account all exports of goods.

Figure 1 shows exports by category. In 1986, when Mexico signed the GATT, primary products represented 51.9% of total exports, whereas science-based and specialized suppliers accounted for 14.6%. By 2012, the share of primary goods had been reduced to 19.5%, while the latter reached 38.4%. The share of supplier dominated and scale intensive goods in total exports was also increased between 1986 and 2012. In 2012, TV sets, mobile phones, computers and cars were among the most important exported products by Mexico.

Figure 1
Mexico: manufacturing exports of goods by category



Source: Own elaboration based on ECLAC (Software SIGCI).

Another indicator of the diversification of production structure is the total number of products exported. In 1986, Mexico exported 631 different goods (at four digits of the Standard International Trade Classification), while by 2012 the number had increased to 745 (ECLAC, 2014a).

Export growth was particularly robust in sectors that experienced a significant growth in global trade. In 2012, 53.7% of Mexico's exports took place in sectors whose global trade grew above the average between 1990 and 2012 (COMTRADE, 2014). Indeed, its exports observed a significant increase not only in high-growth manufacturing goods, such as electronics and medical devices, but also in dynamic primary products such as oil, silver and flowers.

[5] It comprises pharmaceuticals, electronic goods and components, scientific instruments and electrical machinery and equipment. Pavitt's original taxonomy distinguishes between science-based and specialized suppliers. Yet this paper groups them together because in Mexico they present similar features regarding innovation sources and dynamics.

Mexico's exports to the United States' market have been also oriented to dynamic sectors. Table 1 presents the structure of Mexico's exports distinguishing two dimensions: the vertical axis differentiates dynamic products from stagnant products, that is those with positive growth in terms of their share or contribution to global United States' imports from those with negative growth rates over a given period (1990-2012). In the same vein, the horizontal axis differentiates products with positive growth rates in terms of their share or contribution within Mexico's exports to the United States from those with negative growth rates. The first quadrant groups products which increased their share in global United States' imports, and at the same time increased their contribution within Mexico's exports to the United States between 1990 and 2012. The second quadrant comprises products which increased their contribution to global United States' imports, but decreased their share in Mexico's exports to the United States. The third quadrant includes products which decreased both their contribution to global United States' imports and to Mexico's exports to the United States. Finally, the fourth quadrant includes products which increased their contribution to Mexico's exports to the United States, but decreased their share in global United States' imports.

Table 1
Mexico and the United States: product contribution matrix 1990-2012

+	2nd quadrant	1st quadrant
Product contribution to global United States' imports	20.4%	49.9%
	3er quadrant	4th quadrant
	5.8%	23.9%
-	- Product contribution to total +	
	Mexico exports to the United States	

Source: Own elaboration based on software MAGIC (ECLAC, 2014).

Between 1990 and 2012, 70.3% of Mexico's exports were oriented to dynamic markets, that is products that increased their contribution in global United States' imports (first and second quadrants), and a half (49.9%) increased their share in total Mexico's exports to the United States (first quadrant).

In summary, over the last three decades Mexico's economy has gone successfully through two out of three factors of structural change: composition of exports and positive insertion

into global markets. The following section studies in detail the third factor needed for a complete structural change: productivity growth.

3. Productivity growth and structural change

The dataset for Mexico contains series for 68 industries over the period 1990-2012. In order to benchmark the performance of labor productivity, the results are compared to those of the United States, using the dataset developed by Jorgenson et al. (2012)[6], which contains data for the period 1947-2010. Aside from the United States being the standard choice to benchmark the evolution of productivity growth, it is Mexico's largest trading partner: in 2013, 78.8% of Mexico's exports were sent to the United States' market. Moreover through NAFTA, the integration of certain sectors of the two countries, particularly manufacturing, has been substantial over the period studied.

The top panel of figure 2 plots the annual GDP growth rates for Mexico and the United States. The first feature to note is that both series exhibit significant co-movement across the period studied, which reflects the extent of the linkages between both economies. The second aspect to remark is that economic growth in Mexico has been markedly more volatile, which in turn reflects the still elevated vulnerability of the Mexican economy to internal and external shocks.

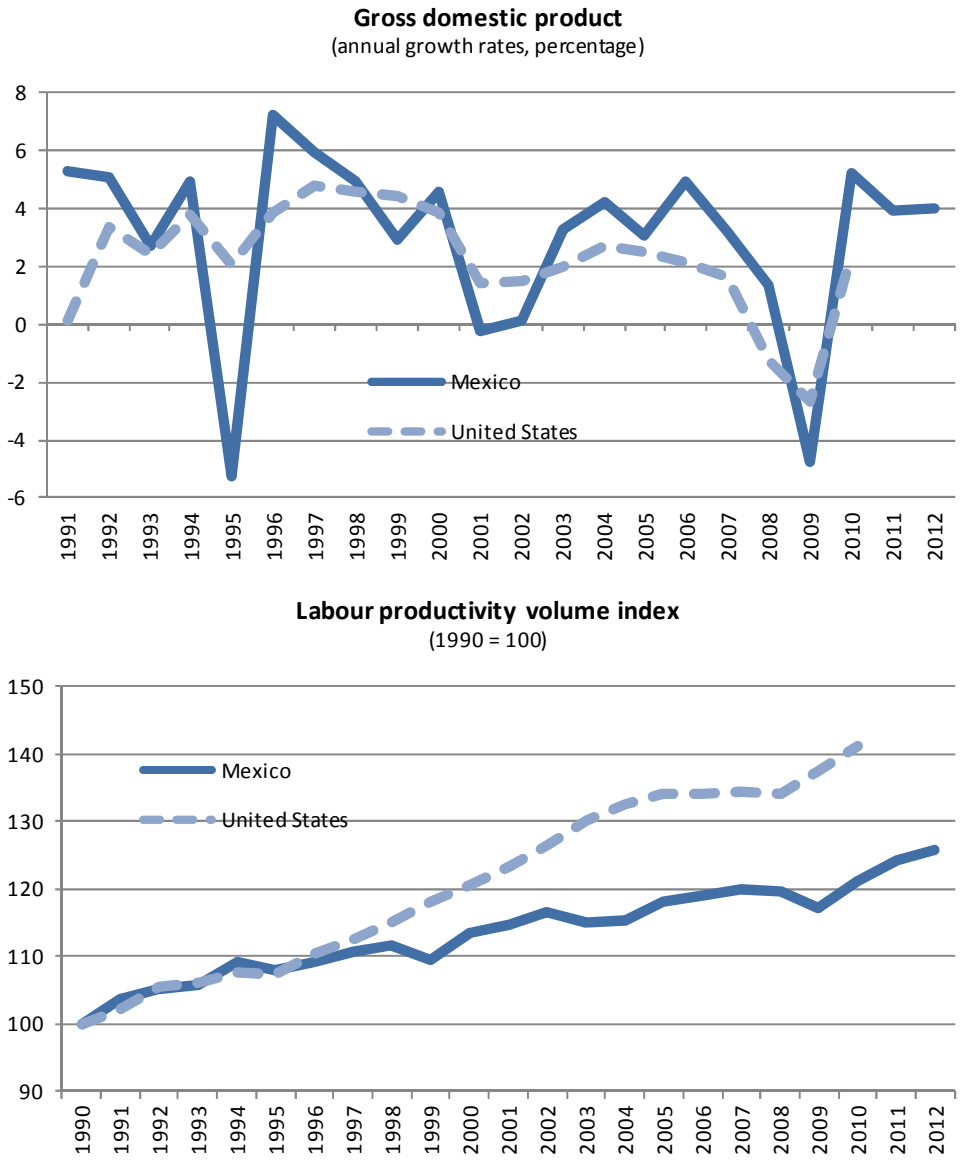
The bottom panel of figure 2 shows the evolution of labor productivity in both countries, where for comparison purposes the value for 1990 has been normalized to 100. The evolution of labor productivity in Mexico clearly reflects the volatility of aggregate growth. Moreover, while economic growth has been relatively similar over the 1990-2012 period, since the second half of the 1990s labor productivity growth in Mexico has persistently lagged behind that of the United States, thus increasing the already sizeable productivity gap.

It is important to acknowledge that slow productivity growth has been closely associated with modest economic growth, as has been previously analyzed by various authors (McKinsey Global Institute, 2014; OECD, 2013; Kehoe and Ruhl, 2010; López-Córdova, 2003). Between 1990 and 2012, Mexico's economy grew only at 2.2% annually on average.

The average annual growth rate of labor productivity in Mexico over the period 1990-2012 was 1.1%, which is significantly lower than the rate of 1.7% of the United States. With respect to other middle income Latin American countries, Hofman et al. (2014) found that over the period 1995-2007 labor productivity growth in Mexico doubled the rate found for Brazil (0,63%), but lagged behind those of Argentina (1,68%), Chile (2.56%) and the United States (2,02%). To put these growth rates into perspective, they imply that whereas it would take 28 and 35 years for productivity levels in Chile and the United States, respectively, to double, it would take 43 years for Argentina, 60 years for the case of Mexico and over 100 years for Brazil.

[6] Since price and volume data for the United States are chain-weighted, aggregation of industry-level volume data is carried out by constructing appropriate Thornqvist price indices to deflate current value series.

Figure 2
Mexico and the United States 1990-2012: GDP growth and labor productivity



Source: Own elaboration based on INEGI (2014) and Jorgenson et al. (2012)

The evolution of productivity highlights two salient features of the Mexican economy. First, shifts in sectoral composition and insertion into high-growth global markets have not been accompanied by rapid productivity growth. Therefore, it is here argued that Mexico has experienced an incomplete or unfinished structural change. Second, economic theory predicts that growing integration between two economies should result in convergence of labor productivity, however the gap between the United States' and Mexico's productivity has widened over the last two decades.

As is well known, countries in general go through phases of growth, stagnation and decline. Taking this into consideration, in addition to the results for the whole sample the shift-share decomposition is computed for the growth periods identified within the sample for Mexico. The growth periods are bracketed by the occurrence of three crises, which resulted in recessions of varying magnitude in Mexico. The first occurred in 1995 associated to severe mismatches in the Mexican balance of payments. The second took place in 2001, as a consequence of the piercing of the so-called dot-com bubble in the United States. The final crisis spilled over from the United States to the global financial system in 2008-2009.

Table 2 summarizes the shift-share decomposition for both countries for the four identified growth periods, as well as for the whole sample. The figures in the top panel correspond to the annual average growth rates of each component, while those in the bottom panel are the contributions of each component to total change. As previously noted, commencing with the full sample (column 5), the growth rate of labor productivity in Mexico is significantly smaller than the one observed for the United States. This reflects differences in both the relative importance of the components and in the growth rates.

As for the relative importance of the components, inspection of the bottom panel of table 2 shows that, in close association with different levels of development between the two countries, in the United States all productivity growth was originated by intra-industry improvement, while in Mexico 37,8% percent of productivity growth was due to the flow of labor between industries.

Hofman et al. (2014) find similar results when comparing developed and emerging economies: on average the contribution of the inter-industry effect on aggregate labor productivity change for Germany, Austria, Belgium, Denmark, Finland, France, Italy, the Netherlands and the United Kingdom over the period 1995-2007 is less than one percent; whereas its contribution for Argentina and Chile are 16% and 11%, respectively.

Regarding the growth rate of the components, the expansion of the intra-industry effect in Mexico (0.7%) has been less than a half of the rate of the United States (1.8%). Although the growth rate of the inter-industry component in the United States is negative, its weight is negligible, whereas for Mexico its growth rate has averaged 0.4%. In contrast to catching-up theories, the productivity gap between Mexico and the United States has not led to faster expansion in the former. In addition, the United States, given its economic development level, seems to have depleted the space to increase productivity through inter-industry shifts, whereas Mexico still has some room.

The decomposition of inter-industry change contributions in Mexico sheds light into the effect of the reallocation of resources across industries. The top panel shows that while the static effect has experienced an average annual rate of 0.8%, the dynamic effect has actually contracted by 0.4% on average. Examining the contributions of each of the components to total change, the bottom panel clearly indicates that the shifts in the relative weights of each industry with respect to total hours worked, that is the static effect, explains close to 70% of total productivity growth. However, the negative sign on the contribution of the dynamic effect, which halves the aggregate structural change effect, implies that despite the higher productivity level of industries which are absorbing a larger labor share, the rate of productivity growth is stagnant or contracting. The labor market in both countries is highly dynamic, allowing for significant shifts among sectors. Yet, in the United States such shifts have been towards more dynamic sectors.

Table 2
Mexico and United States: Shift-share decomposition of labor productivity growth

	(1) 1990-1994	(2) 1995-2000	(3) 2003-2007	(4) 2009-2012[c]	(5) 1990-2012[d]
	Annual average growth rates				
Mexico					
Labour productivity change	2.2	1.0	1.0	2.4	1.1
Intraindustry effect	3.9	-0.1	0.8	2.5	0.7
Interindustry effect	-1.9	1.1	0.2	-0.1	0.4
Static effect	-0.9	1.4	0.3	-0.1	0.8
Dynamic Effect	-1.0	-0.3	-0.1	0.0	-0.4
United States [a]					
Labour productivity change	1.9	2.3	0.8	2.7	1.7
Intraindustry effect	2.1	2.6	0.8	2.9	1.8
Interindustry effect	-2.7	-2.0	-3.4	-1.8	-2.5
Static effect	-2.7	-2.0	-3.4	-1.8	-2.5
Dynamic Effect	-2.5	-1.7	-3.5	-1.6	-2.3
	Contribution to aggregate labour productivity change				
Mexico					
Labour productivity change	100.0	100.0	100.0	100.0	100.0
Intraindustry effect	180.2	-11.6	82.1	103.4	62.2
Interindustry effect	-80.2	111.6	17.9	-3.4	37.8
Static effect	-38.3	144.1	26.3	-2.2	68.8
Dynamic Effect	-41.8	-32.5	-8.4	-1.2	-31.0
United States [b]					
Labour productivity change	100.0	100.0	100.0	100.0	100.0
Intraindustry effect	105.0	108.1	99.4	104.8	102.8
Interindustry effect	-5.0	-8.1	0.6	-4.8	-2.8

Static effect	-4.4	-7.6	0.9	-4.9	-2.5
Dynamic Effect	-0.7	-0.6	-0.4	0.1	-0.3

Notes:

a\ Since the series for the United States are chain-weighted, annual average volume growth rates are computed by first calculating the nominal growth rate, and then deflating by the corresponding Thornqvist index approximation to the Fisher ideal index (see Whelan 2000 for details)

b\ For the case of the United States the contribution of each component to aggregate labour productivity changes is approximated using nominal shares.

c\ 2009-2010 for the United States

d\ 1990-2010 for the United States

Source: Own elaboration based on INEGI (2014) and Jorgenson et al. (2012)

The analysis by growth spells reveal that except for the 1995-2000 period, aggregate productivity in Mexico during expansion episodes has grown at rates that are comparable to those of the United States. This means that part of the lower productivity expansion observed in Mexico for the full period is explained by the losses that occur during crises[7]. Indeed the data indicate that in the 1995 labor productivity contracted by 1% in Mexico and only 0.2% in the United States. Similarly, whereas labor productivity in Mexico fell by an average of 2% during the global financial crisis in 2008-2009, in the United States labor productivity grew 1.1% during the same period. In 2001 when Mexico's labor productivity slowed down to 1.1%, it grew at a rate of 2.3% in the United States. That is, despite exhibiting comparable growth rates during growth spells, labor productivity in Mexico is markedly pro-cyclical during downturns, whereas it exhibits countercyclical behavior in the United States.

With the exception of the second half of the 1990s, in a similar fashion to what has occurred in the United States over the period studied, the main driver of aggregate productivity growth in Mexico has been the effect of improvements within industries. However in contrast to what is predicated by catching-up theories, the effect of the reassignment of resources across industries was negative during the early 1990s and again during the most recent period.

Analyzing the contribution of the components of the inter-industry effect, the results indicate that during periods of relatively rapid productivity growth (1990-1994 and 2009-2012) the static effect has been negative, that is labor has flowed from industries with relatively high productivity levels to those with lower productivity levels. As discussed below this could be the result of industry-specific capital intensive investments which increase productivity at the expense of relative labor demand. For its part, the negative sign of the dynamic effect, which signifies that labor flows away from industries where

[7] In a cross-country comparison of business cycle characteristics over the period 1990-2012, Titelman et al. (2013) find that the amplitude and duration of cycles in Mexico during expansions is of a similar magnitude to the average of selected high income countries, and outperforms the average of Latin America and the Caribbean. Nonetheless they are smaller and shorter than those observed in other developing regions, notably East Asia and the Pacific.

productivity is growing faster, exhibits a diminishing pace and was zero during the most recent growth spell.

3.1 Productivity growth at the sector level

Taking advantage of the level of detail available in the data set, the analysis is further disaggregated with the purpose of identifying which groups of industries, if any, are driving the growth of aggregate labor productivity, and to identify the direction of labor flows across industries. In order to keep the analysis tractable, the industries are classified according to the taxonomy described in section 2. In addition to manufacturing, service industries are classified into analogous categories, with the exception of scale intensive services, which are further broken down into industries involved in the development and management of physical and information networks. Within the classification of physical networks industries, two subcategories are identified: the first contains industries related to trade activities, and the second those involved in storage and distribution. This is done because despite the existence of large firms, trade in Mexico is characterized by the presence of a large number of small and mostly informal firms.

In order to capture the flows of resources for the whole economy, two additional categories are also considered. The first, labeled other production, includes construction and utilities, while the second category comprises non-market services, which are services mainly provided by the state. The details of the mapping of individual industries into the aforementioned categories are shown in table A in the appendix.

Table 3 provides details of the contributions of the different industrial categories over the period 1990-2012[8]. As before, the top panel presents the results for Mexico and the bottom panel those for the United States. The first row of each panel of table 3 replicates the magnitudes presented on the last column of the bottom panel of table 1[9]. The rest of the rows show the contribution of each industrial category to the total industries aggregate, that is the individual category's effects add up to the intermediate and eventually to the total aggregate.

The first feature to note is that in general growth rates in Mexico lag behind those of the United States by a wide margin, with the gap in market services explaining the bulk of the gap in aggregate labor productivity growth rates.

Manufacturing productivity growth in Mexico (2.1%) was much lower than in the same industry in the United States (4.6%), in spite of the close integration between those

[8] In the interest of brevity, the results for the growth episodes are omitted. However they are available from the authors upon request.

[9] It is important to note that the average growth rates for the different classifications (column 1) were computed as the quotient between value added and hours worked, with both magnitudes aggregated at the corresponding classification level. This implicitly assumes that hours worked are perfect substitutes across industries, which may be a reasonable assumption for similarly sized and related industries but less so as the level of aggregation increases. This gives rise to some counterintuitive results such as the average growth rate of manufacturing exceeding the average growth rates of its constituent classifications as a result of what statisticians call the amalgamation paradox (Simpson, 1951).

countries, in particular in this industry. The higher growth rate in the United States was boosted by an impressive dynamism of science-based and specialized services manufacture (14.9%). In contrast, in Mexico this category, which in 2013 accounted for 38.4% of total exports, only grew 1.7%. This fact illustrates that although industries such as electronics, aeronautics and scientific instruments are considered knowledge-intensive industries in developed economies, in Mexico they are dominated by labor and scale-intensive process with much lower productivity growth (Padilla-Pérez and Hérnandez, 2010).

Table 3: Mexico and the United States: Incidence on the change in aggregate labor productivity

	(1) Average growth rate 1990-2012	(2) Intra industry effect	Inter industry effect		
			(3) Static	(4) Dynamic	(5) Total
	Mexico				
Total industries	1.1	62.2	68.8	-31.0	37.8
Primary products	0.1	-11.0	18.2	-16.7	1.4
Other production	-0.4	1.7	10.3	-4.2	6.2
Manufacturing	2.1	34.9	-23.0	-2.2	-25.2
Scale intensive	1.9	28.1	-16.5	-1.8	-18.3
Supplier dominated	1.6	3.7	-6.7	-0.3	-7.0
Science-based and specialised suppliers	1.7	3.2	0.3	-0.1	0.2
Market services	1.4	31.4	63.8	-5.5	58.3
Supplier dominated services	0.5	7.5	-2.8	-1.6	-4.5
Scale intensive services: Physical networks	1.2	23.4	14.6	-0.8	13.8
Trade	1.3	17.0	15.6	-0.3	15.3
Storage and distribution	1.0	6.5	-1.0	-0.5	-1.6
Scale intensive services: Information networks	1.7	-0.7	47.8	-2.8	44.9
Knowledge intensive business services	0.7	1.1	4.3	-0.2	4.1
Non-market services	0.2	5.2	-0.5	-2.4	-3.0
	United States[a]				
Total industries	1.7	102.8	-2.5	-0.3	-2.8
Primary products	1.1	2.3	-0.1	0.1	-0.1
Other production	-1.1	5.3	-1.2	0.0	-1.2
Manufacturing	4.6	17.6	-8.6	-0.4	-9.0
Scale intensive	1.4	8.9	-3.8	-0.2	-4.0
Supplier dominated	3.0	3.7	-2.5	-0.1	-2.6
Science-based and specialised suppliers	14.9	5.0	-2.2	-0.2	-2.4
Market services	2.1	57.6	3.0	0.0	3.0
Supplier dominated services	0.0	5.7	1.2	0.0	1.2
Scale intensive services: Physical networks	3.2	11.8	-0.5	0.0	-0.5
Trade	3.8	9.5	-0.7	0.0	-0.8
Storage and distribution	2.1	2.3	0.3	0.0	0.3
Scale intensive services: Information networks	2.9	25.5	-0.9	-0.1	-1.0
Knowledge intensive business services	1.7	14.6	3.3	0.1	3.4
Non-market services	-0.1	20.0	4.3	0.1	4.5

a/ 1990-2010 for the United States

Source: Own elaboration based on KLEMS data.

Productivity growth in the United States was also higher in supplier-dominated manufactures (3% versus 1.6% in Mexico) but not in scale-intensive manufactures (1.9% versus 1.4%). The latter, which accounted for 35.6% of total exports of goods in Mexico in 2013 and comprises industries such as transport equipment, food products and beverages, has experienced significant productivity growth based mainly on process innovations and acquisition of machinery and equipment (Padilla-Pérez and Hernández, 2010; Abdel-Musik, 2004) .

In addition, substantial differences regarding the relative importance of the diverse categories are observed. As can be verified in column 2, in Mexico the main driver of intra-industry productivity growth has been manufacturing, with the scale intensive products category explaining almost half of aggregate within-industry change, followed by physical networks which largely reflect intra-industry productivity gains in trade activities. For its part, in the United States information networks is the most dynamic sector, whereas taken together manufacturing industries account for less than 20% of aggregate intra-industry productivity growth.

Since in general the contribution of inter-industry changes to productivity in the United States is relatively small and thus not comparable to Mexico, in the remainder of this section the analysis focuses on the sources of aggregate inter-industry change for Mexico.

The third column of table 3 shows the contribution of the static inter-industry effect, which as discussed above is positive (negative) for those categories whose share in total hours worked increased (decreased) during the period studied. According to the traditional conception of structural change, negative (positive) static effects should be expected in those industries with relatively low (high) productivity levels. Yet what is observed in the data is a massive flow from manufacturing, which as recently noted is the main driver of intra-industry productivity gains, and to a lesser extent from non-market services into the rest of the economy with market services in general, and trade activities in particular, absorbing the lion's share of these flows. A possible explanation is that intra-industry productivity gains in manufacturing have been the result of investment in capital-intensive technologies which have resulted in a reduction of manufacturing's relative demand for labor.

Although the aggregate effect of this recomposition of hours worked across sectors is positive, the results in the fourth column show that the reallocation has been very inefficient, since the generalized negative sign signifies that either: a) industrial categories with high intra-industry productivity growth rates, such as the manufacturing case discussed above, are reducing their share in total hours worked, or b) labor is flowing towards sectors whose within-industry productivity is falling, such as primary products, information networks and non-market services.

It is remarkable that intra-industry labor productivity has actually declined within information networks, since they include telecommunications and banking, which have been characterized by the introduction of new technologies over the past two decades[10]. In

[10] See, for instance, OECD (2000).

fact closer inspection reveals that the loss of productivity for this category is driven by the real estate sector, which has experienced significant productivity losses, only partially compensated by the gains posted by telecommunications, financial services and to a lesser extent, radio and television. In a similar fashion, practically the totality of the large negative dynamic effect observed in primary production is the result of an expansion in the relative share of hours worked in oil and gas extraction, which has experienced important productivity losses.

Within the scale intensive sector, the majority of the decrease of the dynamic effect is due to the reduction in the share of total hours worked in petroleum products manufacturing and the basic metal industry, which are the top two scale intensive industries in terms of gross productivity gains. The effect was only partly offset by the modest expansion in the share of hours worked in transport equipment manufacturing which ranks third in gross productivity growth over the studied period.

In aggregate, as shown in the last column of table 3, the negative dynamic effect halves the impact of labor shifting across industries. In other words, if as predicted by the theory labor had shifted from low to high productivity industries, aggregate labor productivity growth over the last two decades could have been almost a third higher in Mexico.

4. Conclusions

Over the last two decades, Mexico has gone through an unfinished structural change process. There has been a shift towards more knowledge-intensive industries, the production matrix has been diversified and exports have oriented successfully towards dynamic markets. Yet productivity growth has been insufficient and way below that of its main trade partner, the United States. Furthermore, structural change has resulted in shifts of labor force from sectors with high productivity growth to those with low productivity expansion, evidencing a significant structural heterogeneity

This paper analyzed the role of the reallocation of hours worked across industries over the period 1990-2012 in the determination of labor productivity growth, disaggregating sectoral dynamics. The results show that labor productivity growth in Mexico was notably lower than that of the United States between 1990 and 2012. Consequently, the productivity gap between those countries widened, in spite of their increasing trade integration. During economic expansion periods, Mexico's labor productivity has grown at a similar rate to that of the United States. However, economic downturns have been both more frequent and deeper in the former, impacting negatively its annual average growth rate.

The main source of labor productivity growth in Mexico was intra-industry productivity gains, driven by improvements found within scale intensive manufacturing and trade. In contrast to the United States, where the impact of the reallocation of resources across industries is negligible, reflecting its level of development, in Mexico close to 40% of structural change is due to the inter industry effect.

Although the flow of labor has in general been from low productivity to higher productivity industries, as evidenced by the positive aggregate static effect, certain high-productivity

industries such as scale intensive manufacturing have seen a decline in their relative labor share in favor of sectors with lower productivity levels such as the production of primary products. Moreover, the generalized negative sign of the dynamic effect indicates that labor is flowing from industries where productivity is growing faster towards industries where productivity is either growing at a slower pace or contracting. In aggregate terms, the inter industry effect points towards a deindustrialization, which in contrast to what has been observed in developed countries, in Mexico it has taken place in an environment of low productivity growth and with labor flowing towards a services sector with very modest productivity.

The new economic model has successfully achieved some of its main goals: export competitiveness, production diversification, closer integration with the United States economy and a shift towards more complex industries. However, these achievements have not been accompanied by robust productivity growth, hampering economic growth as shown by various authors (for instance, ECLAC, 2012 and 2014c; OECD, 2013; Kehoe and Ruhl, 2010; López-Córdova, 2003).

Three final remarks emerge from the analysis. First, active public policies are needed to foster productivity growth in all sectors. The substantial productivity growth differences between science-based and specialized suppliers manufactures in the United States and Mexico illustrates that the shift towards more complex industries in the former country has not been accompanied by increasing innovation capabilities. Policies to support human capital formation, research and development activities and infrastructure, among others, are needed to strengthen productivity growth. Following Abramovitz (1986), a country has strong potential for productivity growth, as a result of economic integration with a technologically-advanced nation, if it has previously developed social capabilities.

Second, low productivity growth in market services is closely associated with a large informal sector. Micro and small-sized firms that do not have access to credit and new sources of knowledge and technologies, struggle hard to increase productivity. Since market services are attracting a significant amount of the labor force released by more productive sectors, public policies are urgently needed to support the informal sector.

Third, economic crises over the last two decades have hindered significantly long-term productivity growth in Mexico. During economic growth periods between 1995 and 2012, the productivity gap between the United States and Mexico has been reduced. Yet economic crises as a result of both domestic and external shocks have had a disruptive effect on productivity growth in Mexico. Counter-cyclical economic policies, which pay more attention to real stability rather than to nominal, are also needed.

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Appendix

Table A

Industry	NAICS 2007 Codes	Category
Agriculture	111	Primary products
Animal breeding and production	112	Primary products
Forestry	113	Primary products
Fishing, hunting and trapping	114	Primary products
Services related to agricultural and forestry activities	115	Primary products
Oil and gas extraction/Services related to mining/Pipeline transportation	211/213/486	Primary products
Metallic and nonmetallic ore mining, except oil and gas	212	Primary products
Electric power generation, transmission and distribution	221	Other production
Water and gas supply through mains to final consumers	222	Other production
Construction	236	Other production
Civil engineering construction works	237	Other production
Specialized construction works	238	Other production
Food industry	311	Scale intensive
Beverage and tobacco industries	312	Scale intensive
Textile inputs manufacturing, and textiles finishing	313	Supplier dominated
Textile products manufacturing, except apparel	314	Supplier dominated
Apparel manufacturing	315	Supplier dominated
Leather and hide tanning and finishing, and manufacturing of leather, hide and allied materials products	316	Supplier dominated
Wood industry	321	Supplier dominated
Paper industry	322	Supplier dominated
Printing and related industries	323	Supplier dominated
Petroleum and coal products manufacturing	324	Scale intensive
Chemical industry	325	Scale intensive
Plastic and rubber industry	326	Scale intensive
Nonmetallic mineral products manufacturing	327	Scale intensive
Basic metal industry	331	Scale intensive
Metal products manufacturing	332	Scale intensive
Machinery and equipment manufacturing	333	Science based and specialized suppliers
Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing	334	Science based and specialized suppliers
Electric appliances, accessories and electric power generation equipment manufacturing	335	Science based and specialized suppliers
Transportation equipment manufacturing	336	Scale intensive
Furniture, mattresses and blinds manufacturing	337	Supplier dominated
Other manufacturing industries	339	Supplier dominated
Trade	430	Physical networks (trade)
Air transportation	481	Physical networks (storage and distribution)

Industry	NAICS 2007 Codes	Category
Rail transportation	482	Physical networks (storage and distribution)
Water transportation	483	Physical networks (storage and distribution)
Freight truck transportation	484	Physical networks (storage and distribution)
Passenger transportation by road, except by rail/Sightseeing transportation	485/487	Physical networks (storage and distribution)
Services related to transportation	488	Physical networks (storage and distribution)
Postal services/Courier and messenger services	491/492	Physical networks (storage and distribution)
Warehousing services	493	Physical networks (storage and distribution)
Newspaper, magazine, book, software and other materials publishing, and integrated publishing and printing of these publications	511	Supplier dominated
Film and video industry, and sound recording industry	512	Supplier dominated
Radio and television/Other information services	515/519	Information networks
Telecommunications/Electronic data processing, hosting, and other related services	517/518	Information networks
Financial and insurance services	52	Information networks
Real estate services	531	Information networks
Rental and leasing of tangible goods	532	Supplier dominated services
Rental services of trademarks, patents and franchises/Head offices	533/551	Knowledge intensive business services
Professional, scientific and technical services	541	Knowledge intensive business services
Business support services/Waste management and remediation services	561/562	Supplier dominated services
Educational services	611	Non-market services
Outpatient medical services and related services	621	Non-market services
Hospitals	622	Non-market services
Social assistance and health care residential facilities	623	Non-market services
Other social assistance services	624	Non-market services
Artistic, cultural and sporting services, and other related services	711	Supplier dominated services
Museums, historical sites, zoos and similar institutions	712	Supplier dominated services
Amusement services in recreational facilities and other recreational services	713	Supplier dominated services

Industry	NAICS 2007 Codes	Category
Temporary accommodation services	721	Supplier dominated services
Food and beverage preparation services	722	Supplier dominated services
Repair and maintenance services	811	Physical networks (trade)
Personal services	812	Supplier dominated services
Associations and Organizations	813	Supplier dominated services
Private households employing domestic personnel	814	Supplier dominated services
Legislative, governmental and justice administration activities	931	Non-market services
Extraterritorial and international organizations	932	Non-market services